An Evaluation of Perforated Steel Plate Shear Walls System

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Abstract

In the last four decades, steel plate shear walls have been used as a lateral-seismic load system in high-rise buildings. The main task of the steel shear wall is to withstand the forces generated by the floors and the resulting overturning of the earthquake, as well as the stable cyclic behavior against large deformations. This system is used based on the need of engineers in various types of composite, reinforced and perforated steel plate shear walls. The use of a perforated steel plate shear wall is intended to solve the executive problems in the upper floors of high-rise buildings. To this purpose, it attempts to achieve an equivalent behavior to the solid steel plate shear wall by thickening and piercing the plate. According to the studies, the (holes) perforations should be wide across the surface of the plate and there should be a path to transfer the force among the perforations so that the perforated strips do not intersect. Moreover, an analysis of an individual strip can be done by evaluating the whole plate; in this way, the behavior of the whole system can be obtained. In this thesis, a sample of this type of perforated steel shear wall is evaluated by using ABAQUS software and analyzing the geometric nonlinear finite elements of materials and various parameters of yield stress, strain and strength concentrations are also investigated. In this regard, by varying the thickness of the plate and the sizes of the perforations and the distance of the perforations, it is attempted to obtain a virtual range for the dimensions and intervals of the perforation so that the yield stress concentration around the perforations does not cause the system malfunction and eventually the entire capacity of the plate will be used. The permissible range is determined in a way that at the moment the perforations' edge reaches the hardening strain, the rest of the plate reaches its yield strain. Accordingly, the results show that the more the perforations are spaced apart, the greater the strain plates are in line with the applied force in the area between the two perforations, and the shorter the distance, the upper and lower border of the strip is more expanded to the middle. Also, in o rder to balance the yield stress and strain behavior between the two perforations, and to place the ratio of stresses and strains to the entire strip width of 0.9 to 1.1, the center-to-center distance of the two perforations should be 4.5 times more than the perforation's diameter. The proper diameter of the perforation should be 60% of the perforated strip's width for all thicknesses to ensure that while there is a stress concentration around the perforation, the total capacity of the plates is used. As the results show, the strength of the system is reduced by making a perforation in the plate. In this study, by applying the empirical formula, the shear strength reduction of the perforated shear wall system is calculated with respect to the non-perforated shear. Thus, based on the design requirement, the thickness of the plate can be increased and an equivalent behavior of the solid steel plate shear wall can be achieved by thickening and piercing the plate.

Key Words: Perforated steel shear wall, ABAQUS, Nonlinear finite element analysis, Hardening strain